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AN ASSESSMENT OF THE SOIL FERTILIZATION STATUS OF IB-INW ZONE OF RAJASTHAN

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ABSTRACT

All soil samples were separately monitored for physical and chemical variables like pH, electrical conductivity (E.C.), nutrient concentration of nitrogen (N), potassium (K), phosphorous (P), organic carbon (O.C.), organic matter (O.M.), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), classification exchange capacity (CEC), texture, CaCO3, D.I.D., water holding capacity and topography slope. Some strong DI values were calculated in soil physical and chemical parameters between reference site (TFS) and other (TPS and COS) sites. In COS, highest increasing and decreasing DI value for sand and silt content were found-53.67% and +71.42%, respectively. Overall in the IB-INW zone, deficiency of organic carbon and nitrogen nutrient were more pronounced. Soil potassium concentration was found medium to high range in studying zone. On the other hand, sufficient availability of copper and manganese micro-nutrient concentration were measured. The data revealed that TFS sites fertilization status was high while TPS and COS were moderate and low fertilization status, respectively. This study will help them to understand the present challenges of soil and problem of soil fertility degradation in Rajasthan.

KEYWORDS: Micro-Nutrient, IB-INW Zone, TFS, TPS, COS, DI Value, Entisols & Aridisols

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Original Article

1. INTRODUCTION

The health of crops mainly depends on soil because it is the natural source of nutrition, water etc. Soil is a critical and unique factor which directly affects the quality and production of products. In soil mainly: minerals, water, organic matter, living organisms and air components are present. These components are mainly included in three parameters of soil namely chemical, physical and biological parameters. These parameters are capable to characterize the fertility of soil (Abbott and Murphy, 2003). Fertility is the ability of soil to support the growth of plants and crop, this ability depends on the characteristic of soil, the presence of minerals, water, type of soil etc. Fertility is the fundamental character of the soil (Howard, 1941; Stefanic, 1994; Stefanic and Gheorghita, 2006; Stefanic et al., 2001; Vaillant, 1901; Williams, 1947). The fertility is described by the efficiency of soil which able to provide the essential nutrient amount to plants for growth (Foth and Ellis,1997; Tisdale et al., 1985), produces the high and healthy product (Campbell, 1978). It means that the maintenance of soil fertility is very important to human health and sustainability of ecology (Scholes, 1990) The analysis of poor fertile soil is essential to know and resolve the actual problems of soil as well as analysis of fertile soil is essential to maintain its fertility.

We are very well known that, a large part of Rajasthan land is still uncultivated because of many natural and human reasons. According to agro-climatic zone, whole Rajasthan province is divided into ten zones (Hussain, 2015). In this work, soil of the IB - INW zone that means IB- irrigated northwestern zone was studied. Total geographical area (TGA) of Rajasthan province is 342239 km^2. The IB-INW zone covers 20634 km^2

geographical areas. In this zone mainly sugarcane, mustard, pearl millet, cluster bean, gram, coriander, orange etc. are produced in cultivated area. At the current time, highly agrarian production is essential to accomplish the demands of regularly and rapidly growing population. As well as, the conservation and reclamation of the product quality is necessary to maintain health of present and future generation.

Crop production and yield depends on the soil nutrient concentration at sufficient time as well as also influenced by physico-chemical properties viz. organic carbon, soil texture, pH, calcium carbonate and electrical conductivity (Bell and Dell, 2008). When these parameters like essential nutrient and micro-nutrient are present in quite higher and lower limits than acceptable limits, they negatively affect the health of the environment and also living organisms. These all parameters are equally responsible and important to maintain the fertility of the soil (Tale and Ingole, 2015). In short, soil fertility is clef and helps to maintain the sustainable agriculture product (Prasad and Power, 1997).

Soil parameters such as chemical, physical and biological parameters are essential to be analysed to make nutrient planning and to enhance the fertility of non-fertile land soil. So the aim of this work is to analyze the fertilization status by evaluating chemical parameters like pH, electrical conductivity, organic matter, the availability of nutrients: major (N, P, K), trace (Fe, Mn, Cu, Zn) elements and physical parameters like texture, water holding capacity, CEC, soil drains and $CaCO_3$ in IB-INW zone of Rajasthan.

2. MATERIALS AND METHODS

2.1. Study Area

This study was carried out in IB-INW zone of Rajasthan province (**Figure 1**). The samples for experiments were collected from each of the soil group like *torrifluvents, torripsamments and calciorthids.* The *torrifluvent* soil sample collected from the farm land of spread over Tibbi, Hanumangarh, Suratgarh, Vijaynagar and Anupgarh, respectively. Rice and wheat crops are majorly grown in this area. The soils of *torripsamment* and *calciorthids* are cover Sri Ganganagar, Karanpur, Padampur, Raisinghnagar, Suratgarh, Anupgarh, Sangaria, Sadulsahar, Rawatsar, Nohar, Bhadra and Hanumangarh. Cotton, sugarcane and wheat is major crop of *torrripsamment* soil area. The *calciorthids* soils group is covered poor or non-cultivated land. According to agro climatic zones, all sites are part of the IB-INW zone in Rajasthan province. International border of Pakistan forms north and northwestern boundary of studied zone. And northeastern boundary forms by Punjab and Haryana province, Churu and Bikaner districts of Rajasthan province from south boundary of study zone.

The average annual rainfall of the zone is 225 mm. The mean minimum temperature is 5.5˚C and maximum temperature is 40.5˚ C (Source: Raj. govt. official website). It is an arid region characterized by extreme hot and cold season. There is a summer season from April to June, rainy season from July to mid-September, post-monsoon season from mid-September to October and winter season expends from November to March. The climate of the IB-INW zone of Rajasthan is arid and hot.

2.2. Soils

The soils of IB-irrigated north western zone of Rajasthan province have been classified in *torrifluvent, torripsamments* and *calciorthids* soil great group (Shyampura and Sehgal, 1995). The soils of the *torrifluvent* (TFS) group are mainly derived from alluvium deposits brought down by Ghaggar River. The soils are pale brown to yellowish brown in colour. The soils of *torripsamment* and *calciorthids* are the dominant alluvials and are light brownish gray to brown in

colour. The Gang, Bhakra and Indra Gandhi canal are the major source of irrigation of *torripsamment* (TPS) and *calciorthids* (COS) soil areas. The Entisols (*torrifluvent, torripsamments*) and Aridisols(*calciorthids*) soil orders are dominant in studied zone (Mathur, 2001).

2.3. Soil Sampling

Soil samples were separately collected from 220 sites of the IB - INW zone. Each sample was collected from topsoil at 0 to 6 inches depth of ground level to obtain 3 kg weight. Samples were put in white clean polythene beg and properly marked to identified. All samples were transferred to the laboratory for chemical and physical parameter evaluation. Soil sampling was also involved drying, grinding and sieving procedure. Samples were dried in shade at room temperature. The farmland soil sampling was carried out before the planting of crops when the effect of fertilizer and pesticides were lowest. For all experimental determination each air-dried soil sample was conditioned by passing them through a 2 mm sieve before using.

2.4. Physical Measurement

The mechanical compositions of soil were analysed by the international pipette method as described by Robinson (Piper, 1950) Texture class of soil was examined by using the textural triangular method. It is the most fundamental qualitative property that influenced and controlled nutrient, water, oxygen exchange, uptake, retention and other process. Calcium carbonate was measured by Hutchinson’s rapid titration method (Piper, 1950). Available water holding capacity (W.H.C.) or plant available water of soils was estimated by subtracting moisture content permanent wilting point (P.W.P.) from field capacity (F.C.) moisture content. Moisture content at field capacity and permanent wilting point was examined by using the pressure plate apparatus in this experiment (Hillel, 1982).

2.5. Chemical Measurement

All samples were analysed using standard methods. The pH was measured in 1:2 (soil: H_2O) aqueous solutions by using pH meter with a glass electrode (Piper, 1950). E.C. was determined in the extraction of a soil-water 1:2 solution with a conductivity meter. In both experiments, the readings were noted after shaking the slurry on the reciprocal shaker for 30 minutes (Piper, 1950). Total N (mineralization nitrogen) was measured by alkaline permanganate method (Subbiah and Asija, 1956). According to Olsen method, phosphorus was determined. For determination of available P in soil samples sodium bicarbonate method(Olsen et al., 1954) was used and for read the intensity using a red filter on spectrophotometer at 660 nm wavelength. The available potassium in soil was evaluated by flame photometer method with ammonium acetate (Black, 1965). Organic carbon was measured with potassium dichromate by wet digestion method (Walkley and Black, 1934). Total organic matter was calculated by multiplying organic carbon content by the conventional factor 1.724 based on the assumption that organic matter is 58 percent carbon. Micronutrients (Fe, Mn, Cu and Zn) were measured by the DTPA extractable method as outlined by Lindsay and Norvell (1978) and also using atomic absorption spectrophotometer. Cation exchange capacity (CEC) was examined by saturation of soils with 1N sodium acetate (pH 8.2). The soils were classified as low, medium and high in organic carbon, N, P and K as per the criteria given in **Table 3** by Muhr et al. (1965). Micronutrient concentration ranges were measured on the basis of critical limits given in **Table 4** suggested by Lindsay and Norvell (1978).

2.6. Statistical Analysis

Microsoft excel 2007 is used to determine DI values. To evaluate increasing and decreasing order changes in soil parameters under different soil series like *torripsamments* and *calciorthids* soil lands is compared with *torrifluvent* soil land (references). The DI (index of deterioration) was observed as the relative difference between the value of specific soil parameters in TPS and COS compared to reference values of the same soil parameter in TFS (reference) on similar agro-climatic condition of each site. Soil parameters considered for DI calculation were pH, EC, organic carbon, available N, P, K, Zn, Fe, Cu, Mn, CEC, soil content, $CaCO_3$. For the individual soil parameter, the DI was calculated using the equation (1) (Ekanade, 1991):

$$DI = [(X_{TFS} - X_{TPS} \text{ or } X_{COS}) / X_{TFS}] \times 100 \quad (1)$$

Where, X_{TFS} = mean value of soil parameter in TFS (references) land, X_{TPS} = mean value of soil parameter in TPS land and X_{COS} = mean value of soil parameter in COS land.

3. RESULTS AND DISCUSSIONS

3.1. Physical Data Analysis of Torrifluvent Soil Samples (TFS)

These soils are *categorized* as a clay loam. The mean values of soil physical parameters were shown in **Table 1**. The soil content of sand, silt and clay were ranged from 39.7 to 60.4, 11.6 to 26.4 and 19.6 to 36.8 percent with a mean value 53.15, 24.88 and 21.97 percent, respectively. The soil of TFS was heavy *texture*. So there were no significant textural differences among the sites. The *calcium carbonate of* TFS was found from 1.5 to 6.4% with 3.41% mean concentration. In TFS, 86.84% soils were observed in non-calcareous in nature as the classification proposed by FAO (1973). According to Kumar et al. (2017) examined medium range for $CaCO_3$. Mean *available water capacity* was 18 percent measured in *torrifluvent* soil samples. Almost flat *topography* and no natural *drains* were found in TFS sites. The similar trend was analyzed by Mathur (2001).

3.2. Physical Data Analysis of Torripsamments Soil Samples (TPS)

The *textural* class of the TPS was sandy loam investigated which was medium textured. Similar trends were observed by Kaur (2017). The mean values of sand, silt and clay content 78.35, 9.09 and 12.55%, respectively was observed for TPS in observation. The content of sand, silt and clay were varied from 70.5 to 86.5%, 6.2 to 13.8% and 6.1 to 18%, respectively. The range of $CaCO_3$ was observed from 1.2 to 3.5 percent with a mean 2.30 percent in *torripsamments* sampled soil. On the basis of limits suggested by FAO (1973) all TPS under investigation rated low (< 5%) in the $CaCO_3$ content and found in non-calcareous nature. Mean *available water capacity* was 10.57% examined. *Topographyslope* was found almost flat. No drainage intensity of *drains* was observed. Almost similar trend of physical parameter was observed by Mathur (2001).

3.3. Physical Data Analysis of Calciorthids Soil Samples (COS)

The soils were light *textured* and categorized as loamy sand. For *calciorthids* soil series: sand, silt and clay contents were varied from 71.8 to 86.5, 5.6 to 12.2 and 7 to 16.8 percent, respectively. Mean value of sand, silt and clay content was calculated as 81.68%, 7.11% and 11.2 %, respectively. The range of $CaCO_3$ varied from 1 to 3.4 percent. Hundred percent *calciorthids* samples were found in non-calcareous nature as the classification proposed by FAO (1973). Mean *water holding capacity* was 7 percent observed. *Natural drainage* was not found in the site observed. Almost similar

trends were observed by Mathur (2001).

3.4. DI Value between TFS and TPS in Physical Parameters

The different type of soil *textures* were analysed in both TFS and TPS soil series. From TFS to TPS, the texture of the soil was varied from clay loam to sandy loam soil. The increased -47.41% DI in sand content was studied for TPS as compared to TFS. However, in case of silt and clay decreased +63.46% and +42.87% DI values were examined for TPS. In TFS, heavy *texture* was examined and it was a medium texture for TPS. For *calcium carbonate*, the positive DI value +32.55% was examined in TPS. The DI of *water holding capacity* in TPS was less than TFS by +44.44% in decreasing order. However, no significantly difference was observed for all examined sites as a result in *topography slope* and *drainage intensity of drains*.

3.5. DI Value between TFS and COS in Physical Parameters

The light *texture* was observed in COS, on the other side, it was a heavy texture for TFS. From TFS to COS, texture of soil varies from clay loam to loamy sand soil because the fraction of each COS content were analysed relatively differ in comparison to TFS. Increasing DI value of sand content -53.67% was measured in COS as compared to TFS while decreasing +71.42% and +49.02% DI values were analysed for silt and clay content in COS. For $CaCO_3$ the positive DI +39.29% were measured in COS. The DI of *water holding capacity,* +61.11% was observed in COS. It may be because of the presence of low amount of organic matter in COS. No *drainage intensity of drains* difference was observed between COS and TFS.

3.6. Chemical Data Analysis of TFS

Soil *pH* values varied from 7.23 to 8.44 in TFS samples. Soil pH was present in the normal range for 68.43% of TFS examined sites and showed pH values below 8. Remaining 31.57% *torrifluvent* soil sites were moderately alkaline under pH 8 to 9 **(Figure 2a)**. The mean value 7.87 was analysed for pH experiment. If surface soil pH is too low or high, the chemical reactions in soil and plant production efficiency may be affected. In surface soil, low pH values reflect the effect of high organic matter content according to Deenik and Yost (2006). Kumar et al. (1973) observed pH values in normal range for 40% area of TFS. For TFS, the *electrical conductivity* was assessed from 0.25 dS m^{-1} to 2.64 dS m^{-1} with mean value 0.59 dS m^{-1}. In EC values, 86.84% TFS sites showed below 0.8 dS m^{-1} suggesting normal EC to all crops. While 7.89% and 5.27% soil were observed in the range of 0.8 to 1.6 dS m^{-1} and above 2.5 dS m^{-1}, respectively. Similarly, Kumar et al. (1973) and Mathur (2001) evaluated normal range of E.C. in TFS. The mean data are arranged in **Table 2** to different chemical determinations of soil series.

Percent *organic carbon* and *organic matter* were found in 0.12 to 1.02 and 0.20 to 1.75 ranges, respectively. Organic C contents in 55.26 percent TFS showed less than lower (<0.50%) critical status (**Figure 2b**). For organic carbon 42.11% and 2.63% TFS sites were observed in medium and high range, respectively. The mean values of organic C content and organic matter were 0.40 and 0.68 percent calculated in these soil samples. Similarly, low organic matters were determined for Sri Ganganagar by Kumar et al. (1973). Organic matters indirectly affect the productivity of crops and health of soil because it easily provides food to micro-organisms like bacteria and fungi etc. These micro-organisms are capable of changing the organic complex to simple substance, which are easily utilized by plants. *Available N* was assessed from 201 to 278 kg ha^{-1} range with mean concentration value 240.81 kg ha^{-1}. Soil N was present in low level for all TFS sites **(Figure 2c)** but significantly different to each other. Mathur (2001) found the same trends for nitrogen. Results from

this study show some similarity in organic carbon and nitrogen concentrations to those reported by Giri (1993); Singh and Ahuja (1990).

Olsen extractable phosphorus concentrations in TFS, 21.05, 57.90 and 21.05 percent area were measured in low, medium and high range, respectively (**Figure 2d**). The phosphorus ranged from 7 kg ha^{-1} to 56 kg ha^{-1} in TFS. For TFS, similar trends of P concentrations were observed by Mathur (2001) and Kumar et al. (1973). The Mean *phosphorus* concentration was observed 22.41 kg ha^{-1} in *torrifluvent* soil. The available K concentrations ranged from 252 kg ha^{-1} to 484 kg ha^{-1} in the *torrifluvent* soil. Mean K concentration 369.76 kg ha^{-1} was observed. The K concentration was found in high and medium status for 78.95% and 21.05% TFS, respectively (**Figure 2e**). Results from this study show similarity in K concentration to those reported by Mathur (2001) and Kumar et al. (1973).*Cation exchange capacity* was varied from 15 to 31.45 meq/100g with mean value 21.85 meq/100g.

Range of Micronutrient such as *iron* and *zinc* concentrations was varied from 2.9 to 6.4 ppm and 0.20 to 0.73 ppm in the experiment. The mean concentration of iron and zinc nutrient were measured as 4.79 ppm and 0.56ppm, respectively. Sufficient zinc (> 0.6 ppm) and iron (> 4.5 ppm) concentrations were present in 63.16% (**Figure 2f**) and 81.58% (**Figure 2g**) TFS sites. Concentrations of *Cu* and *Mn* nutrient were assessed between 0.24 to 0.63 ppm and 1.98 to 4.25 ppm range. The normal availability was observed in TFS for copper (**Figure 2h**) and manganese (**Figure 2i**) nutrients.

3.7. Chemical Data Analysis of TPS

Soil *pH* varied from 7.29 to 8.64 ranges in TPS. The mean pH 7.78 value was measured for *torripsamments* soil. In TPS, 63.16% sites showed pH in normal (6.5 to 8) range and 36.84% TPS sites were showing moderately alkaline (8 to 9) nature **(Figure 2a)**. Similar trends were reported for Raisinghnagar (Ramana e al., 2015). Most of the pH values were assessed in 8 to 8.5 ranges for seventy two percent areas (Kumar et al., 1973). Data of *electrical conductivity* was observed in 0.20 to 1.26 dS m^{-1} range. 92.11 percent soil samples were observed in normal ranges. The normal EC values means soluble salt concentration was normal in the soil profile and salinity is not a problem in these soils. Remaining 7.89% soil was showing EC from 0.8 to 1.6 dS m^{-1} ranges that critical for salt sensitive crop. The mean EC 0.41 dS m^{-1} was calculated. The trends for E.C. are similar to those reported for TPS (Kumar et al., 1973) and Raisinghnagar (Ramana et al., 2016).

For TPS, *organiccarbon content* and *organic matter* were observed from 0.12 to 0.55% and 0.20 to 0.94% with mean values of 0.29 and 0.50 percent, respectively. Soil OC was assessed in low and medium range for 94.74% and 5.26% TPS, respectively (**Figure 2b**). Almost 76% of sierozems soil showed organic matter in low level (Kumar et al., 1973). In TPS, *nitrogen* varied from 137 to 275 kg ha^{-1} with 210.10 kg ha^{-1} mean value. According to critical range (<280 kg ha^{-1}) suggested by Muhr et al. (1965), all soils were nitrogen deficient **(Figure 2c)**. Similar trends were analysed for available nitrogen by Kumar et al. (1973) and Mathur (2001). Olsen *phosphorus* concentrations varied from 8 to 32 kg ha^{-1}. In which 63.16, 26.31 and 10.53 percent soils were showed medium, low and high availability according to rating, respectively (**Figure 2d**). The mean concentration of exchangeable *potassium* 368.07 kg ha^{-1} was appeared in TPS. Soil K concentration in 60.53% TPS was observed in high range while 39.47% soil assessed in the medium range (**Figure 2e**). Kumar et al. (1973) and Ramana et al. (2015) obtained similar trends of organic carbon, essential nutrient P and K nutrient. *Cation exchange capacity* was varied from 15 to 27.24 meq/100g with mean value 19.11 meq/100g.

Extractable micronutrient concentrations like *copper* and *manganese* were found between 0.21 to 0.58 ppm and 1.90 to 4.62 ppm by helping of atomic absorption spectrophotometer. The mean concentration of copper and manganese nutrient were 0.36 and 3.26 ppm value analysed, respectively. *Torripsamments* soil was showing sufficient availability for copper (**Figure 2h**) and manganese (**Figure 2i**) nutrient in studied zone. Range of *Fe* and *Zn* nutrient were found from 2 to 6.4 ppm and 0.23 to 0.78 ppm in TPS. In TPS, the mean concentration of Fe and Zn nutrient was 4.37 and 0.52 ppm found, respectively. The sufficient availability of iron and zinc nutrients was observed in 63.16% (**Figure 2g**) and 47.37% (**Figure 2f**) TPS, respectively.

3.8. Chemical Data Analysis of COS

The *pH value* of the 52.64 % COS was measured in the normal range (7 to 8 pH) and remaining COS found in 8 to 9 pH. That means 47.36% soil was moderately alkaline in nature **(Figure 2a)**. A similar pH trend was observed by Kumar et al. (2017). The *electrical conductance* of whole COS was present in the normal range that means below the 0.8 dS m^{-1} and values varied from 0.13 to 0.5 dS m^{-1} range. According to Kumar (1973), normal range was observed for EC and pH in COS. *Organic carbon* was varied from 0.09 to 0.44% in COS. Organic carbon content was observed in deficiency (**Figure 2b**). Similarly, organic *matter* was also observed in deficient range. Also this, *available N* concentration was present below 280 kg ha^{-1} value **(Figure 2c)**. The range of nitrogen was found from 132 to 260 kg ha^{-1} with mean concentration 199.02 kg ha^{-1}. The mean *phosphorus* concentration was observed 17.44 kg ha^{-1} within the range of 7 to 47 kg ha^{-1}. The P concentration were assessed in low, medium and high level for 36.84%, 52.63% and 10.53% COS samples, respectively (**Figure 2d**). Nutrient *potassium* concentration was examined from 200 to 374 kg ha^{-1}, in which 86.84% and 13.16% samples were found in medium and high range, respectively (**Figure 2e**).Kumar et al. (2017) observed almost a similar trend for organic carbon, N and K concentration. But, low availability of N, P, K and organic carbon were assessed by Kumar et al. (1973). *Cation exchange capacity* was measured from 26.11 to 12 meq/100g in COS. Similar trends were observed by Mathur (2001).

Concentrations of *zinc* and *iron* micronutrients were varied from 0.19 to 0.68 ppm and 1.3 to 6.4 ppm, respectively. In COS, 73.68 and 60.53% soil samples showa deficiency of zinc (**Figure 2f**) and iron (**Figure 2g**) that concentration of zinc and iron nutrient were present below 0.6 ppm and 4.5 ppm values, respectively. The concentration of *Cu* and *Mn* nutrient were found from 0.21 to 0.56 ppm and 1.06 to 4.21 ppm, respectively. For COS samples, the mean concentration of Mn and Cu was observed 2.43 and 0.35 ppm, respectively. Sufficient availability of Cu (**Figure 2h**) and Mn (**Figure 2i**) were assessed in whole COS sites. The trends of iron and zinc nutrient concentration were similar to our ranges (Kumar et al. 2017).

3.9. DI Value between TFS and TPS in Chemical Parameters

All the soil chemical properties were analysed for different soil series. Each of them showed significant DI value in chemical parameters. For soil *pH* decreased DI +1.14% was measured in the TPS. The *electrical conductance* was significantly greater in TFS compared to TPS. In decreasing order, +30.50% DI was measured for electrical conductance in TPS. In TPS, the decreasing DI +27.50% were found in*organic carbon* content. In CEC, positive +12.54% DI value was calculated. In decreasing order, +12.75% DI value was calculated for *nitrogen* in TPS. In case of *P* and *K nutrient*, respectively decreasing +18.25 and +0.45 DI was assessed in TPS.

The *copper* nutrient was examined in the normal range for all TFS and TPS sites. Although, the positive DI of copper concentration +14.28% was analysed for TPS with respect to TFS. Extractable Cu and Mn nutrient concentration were higher for both TFS and TPS with comparison to critical (0.2 and 1 ppm) values, but significantly different concentration value observed to each other. The increasing (negative) DI of *manganese* nutrient -5.50% was observed for TPS. For iron nutrient concentration, positive DI +8.76 percentile were evaluated in TPS. Similarly, the decreasing DI +7.14% were detected for *the zinc nutrient* in TPS.

3.10. DI Value between TFS and COS in Chemical Parameters

Compared to TFS, *calciorthids* soils showed low *pH* values resulting decreasing DI value +0.88% was observed in COS sites. The positive +49.15% DI was evaluated for *EC* in COS with respect to TFS. More specially, decreasing +52.50% DI were measured for *organic carbon* in COS samples. Similarly, positive +51.47% DI value was observed in *organic matter*. The decrease +17.35% DI value was observed in soil *nitrogen* concentration for COS land sites. The decreases in the available N in these sites reflect the decrease in soil organic carbon. Normally, higher concentration of nitrogen is associated with high organic matter (Whitbread, 1995). In soil *phosphorus* and *potassium* concentration, positive values of DI were +22.17% and +29.20% observed in COS samples.

In COS, positive DI values of *zinc* and *iron*+23.21% and +22.33% were observed, respectively. Similarly, positive +16.66% and +21.35% DI were examined in *Cu* and *Mn* nutrient concentration. In decreasing order, +27.09% DI was measured in *cation exchange capacity*.

4. CONCLUSIONS

This study was undertaken to examine the soil on different parameters for selected soil sites of IB-INW zone. The studied demonstrated soil parameters affect the fertilization status that is strongly related to agricultural production. There were found some strong DI values in soil chemical and physical parameters between reference site (TFS) and other (TPS and COS) sites. In all of the analyzing parameters (except Mn nutrient in TPS, sand content) positive DI values were estimated for TPS and COS. In COS, positive DI +52.50% and +49.15% were measured for organic carbon and electrical conductance, respectively. The DI value of sand content in TPS and COS were found was found in increasing order -47.41% and -53.67%, respectively. Positive DI value +44.44% and +61.11% were found in sandy loam and loamy sand in water holding capacity. The zinc and iron nutrient in 54.38% and 38.59% area (IB-INW zone) were measured in deficient range. While the remaining micronutrient manganese and copper was found to be sufficient range. Deficiency of nitrogen and organic carbon were more pronounced under IB-INW zone. Mostly chemical fertilizers have been blindly used by Farmers to improve soil fertility. Whereby, the negative side effects of fertilizers have been seen on agriculture production, agro-ecosystem and human health. But, bio-fertilizers are more beneficial than chemical fertilizer for agriculture due to low cost and non-hazards effects.

In this zone, we can use bio-fertilizer like Rhizobium, Azospirillum, Azotobactor and Acetobactor to reduce the deficiency of nitrogen nutrient. Which enhance the fertility of TPS and COS sites and improve the yield of crops. This paper traces the soil fertility in IB-INW zone after giving little bio-treatment it will work like a fertile soil.

5. ACKNOWLEDGEMENTS

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6. CONFLICT OF INTEREST

The authors have no conflict of interest.

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APPENDIX

Table 1: Comparative Mean Results for Selected Physical Parameters of the TFS, TPS and COS with Units (n=220)

Parameters	Units	Mean for TFS	Mean for TPS	Mean for COS
Sand	%	53.15	78.35	81.68
Silt	%	24.88	9.09	7.11
Clay	%	21.97	12.55	11.2
Texture (class)	-	H	M	L
Texture (Dominant)	-	Cl	Sl	Ls
$CaCO_3$	%	3.41	2.30	2.07
AW	%	18	10	7
DID	km/sq.km	N	N	N

Note: AW: Available Water; DID: Drainage Intensity of Drains; H: Higher texture; M: Middle texture; L: Light texture; Cl: Clay loamy; Sl: Sandy loam and Ls: Loamy sand; N: No.

Table 2: Comparative Mean Results for Selected Chemical Parameters of the TFS, TPS and COS (n=220)

Parameters	Units	Mean for TFS	Mean for TPS	Mean for COS
pH	-	7.87	7.78	7.80
EC	dS m^{-1}	0.59	0.41	0.30
OC	%	0.40	0.29	0.19
OM	%	0.68	0.50	0.33
N	$kgha^{-1}$	240.81	210.10	199.02
P	$kgha^{-1}$	22.41	18.32	17.44
Total K	$kgha^{-1}$	369.76	368.07	261.76
Cu	ppm	0.42	0.36	0.35
Zn	ppm	0.56	0.52	0.43
Mn	ppm	3.09	3.26	2.43
Fe	ppm	4.79	4.37	3.72
CEC	meq/100g	21.85	19.11	15.93

Note: EC: Electrical conductivity; OC: Organic carbon; OM: Organic matter; N: Nitrogen; P: Phosphorus; K: Potassium; Cu: Copper; Zn: Zinc; Mn: Manganese; Fe: Iron; CEC: Cation exchange capacity.

Table 3: Chemical Parameters Viz. Organic Carbon, Essential Nutrient (N, P and K) Rating and Critical Ranges[37]

Element	Soil Test	Critical level		
		L	M	H
OC	Walkely& Black's	<0.5%	0.5-0.75%	>0.75%
N	Alkaline permanganate	<280 $kgha^{-1}$	280-560 $kgha^{-1}$	>560 $kgha^{-1}$
P	Olsen ($NaHCO_3$)	<12.5 $kgha^{-1}$	12.5-25 $kgha^{-1}$	>25 $kgha^{-1}$
K	NH_4OAc	<135 $kgha^{-1}$	135-335 $kgha^{-1}$	>335 $kgha^{-1}$

H: High; M: Medium; L: Low

Table 4: Micro-Nutrient Viz. Cu, Fe, Zn and Mn Rating and Critical Ranges[36]

Element	Soil Test	Critical values	
		D	S
Cu	DTPA extractable	<0.2 ppm	>0.2 ppm
Fe	DTPA extractable	<4.5 ppm	>4.5 ppm
Zn	DTPA extractable	<0.6 ppm	>0.6 ppm
Mn	DTPA extractable	<1.0 ppm	>1.0 ppm

D: Deficient; S: Sufficient

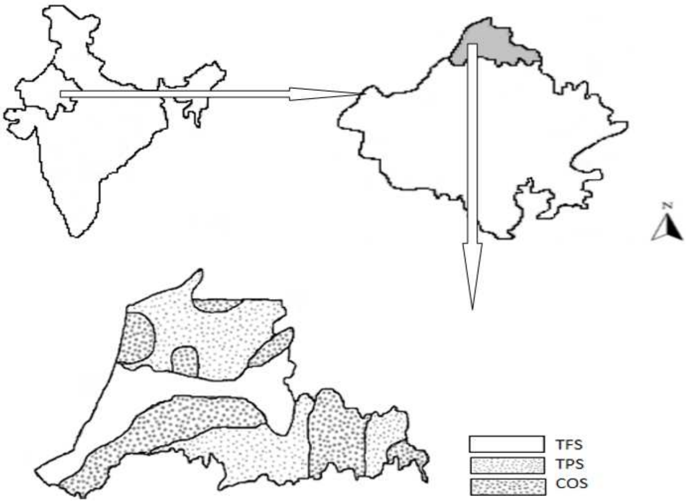
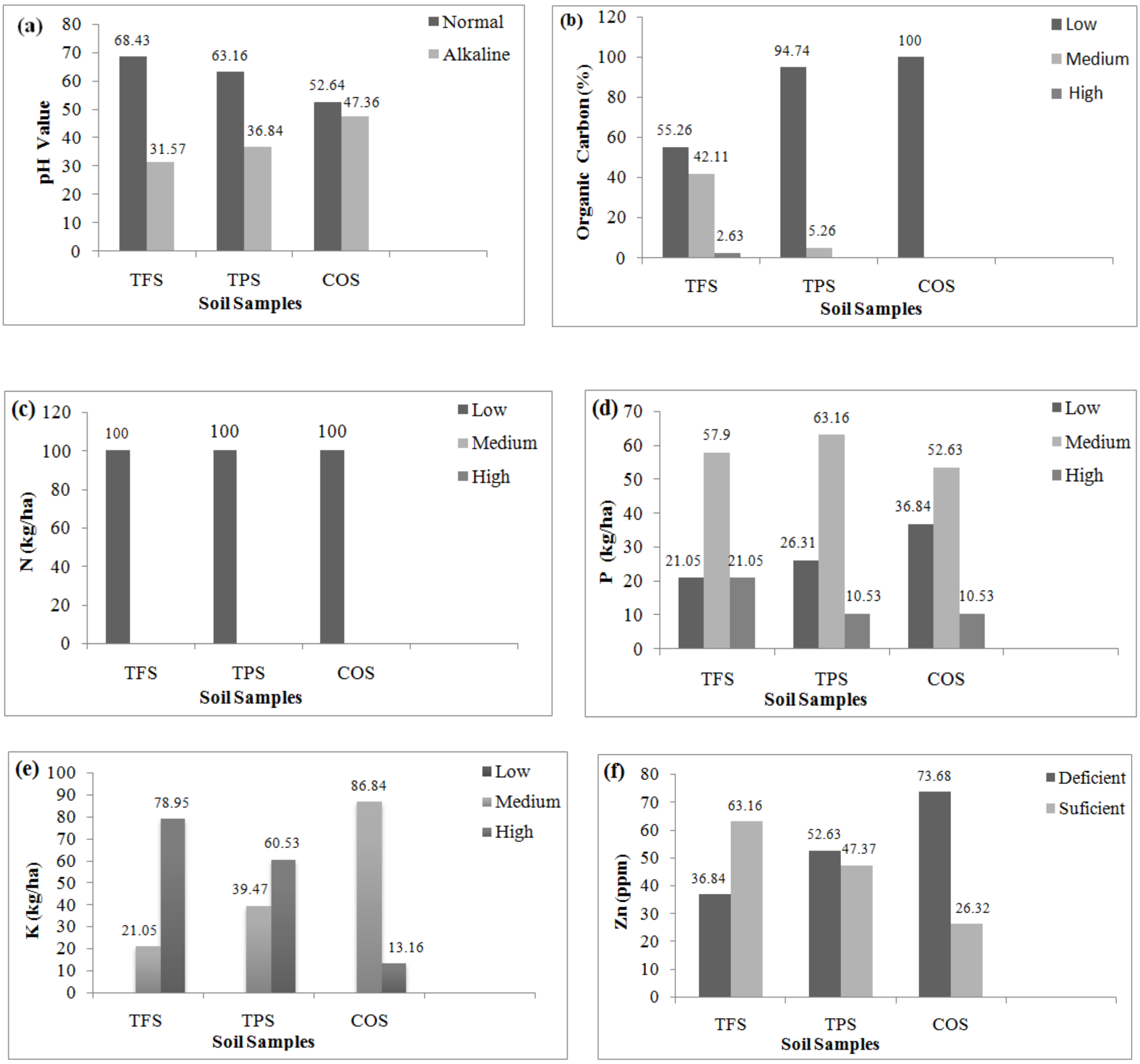


Figure 1: Location of Study Area



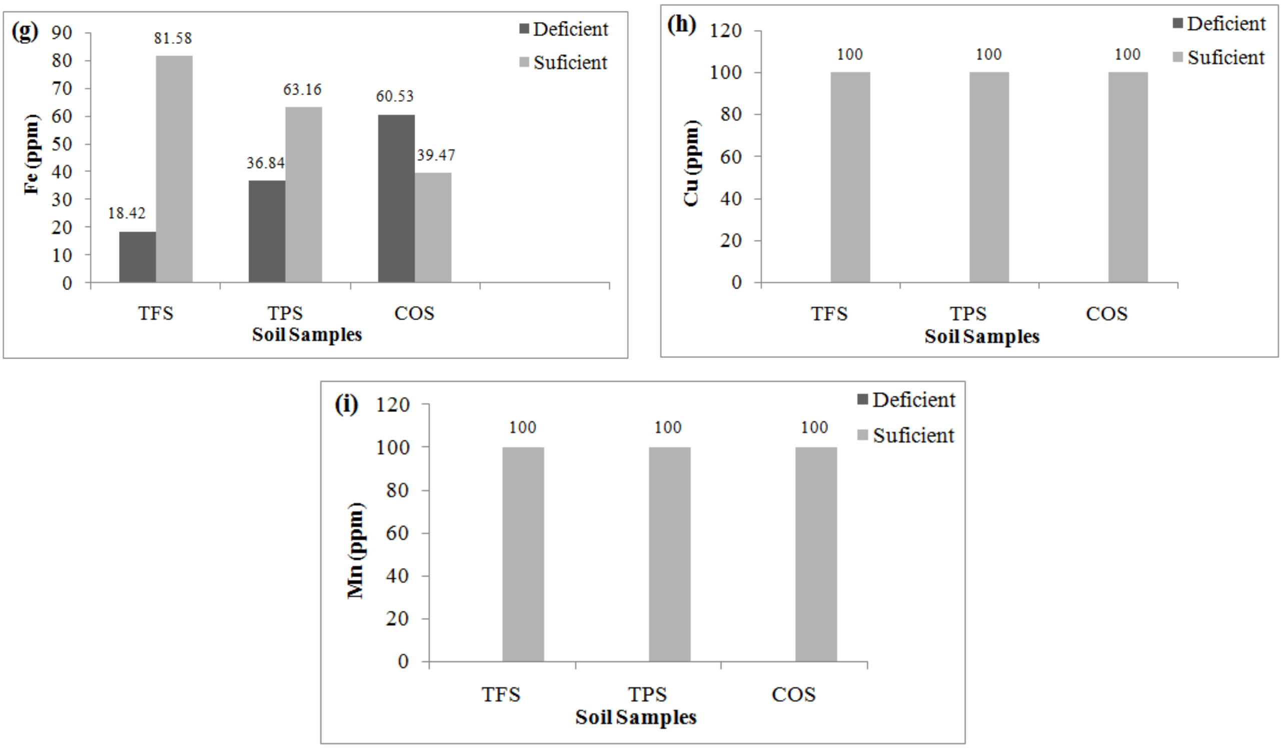


Figure 2: Chemical Parameters: pH; OC; N; P; K; Zn; Fe; Mn and Cu Assessed in TFS, TPS and COS Sites (n=220)